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(54) Title: METHOD OF FORMING FREESTANDING THIN CHROMIUM COMPONENTS FOR AN ELECTROCHEMICAL CONVERTER

(57) Abstract: A method of fabricating a high density thin component which can be used in an electrochemical converter comprises tape casting a material to form a tape followed by hot pressing of the tape to provide additional densification of the material. A plurality of tapes may be laminated together prior to hot pressing to provide a thicker structure or a composite structure. The materials used to produce the component may include silicon carbide, SiC, high chromium alloys, chromium iron alloys, (Cr-5wt%Fe-1wt%Y₂O₃) and chromium magnesium alloys (Cr-5wt%Ni-1wt%MgO). The fabrication method produces a high density component, including the application in an electrochemical converter, having a thickness of less than about 0.03 inches.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of Michael S. Hsu

Attorney
Docket No. HSE-060-1

For: **METHOD OF FORMING FREESTANDING THIN CHROMIUM COMPONENTS FOR AN ELECTROCHEMICAL CONVERTER USING COMBINED PROCESSING TECHNIQUES**

Commissioner For Patents
Box Provisional Patent Application
Washington, DC 20231

CERTIFICATION UNDER 37 CFR 1.10

Date of Deposit: August 13, 2002 Mailing Label Number: EL 931679993 US

I hereby certify that this Cover Sheet for Filing Provisional Application (37 C.F.R. §1.51(2)(i)) and the documents referred to as attached therein are being deposited with the United States Postal Service on the date indicated above in an envelope as "Express Mail Post Office to Addressee" service under 37 CFR 1.10 and addressed to the Commissioner for Patents, Box Provisional Patent Application, Washington, D.C. 20231.

Larry Taylor
Name of Person Mailing Paper

[Signature]
Signature of Person Mailing Paper

COVER SHEET FOR FILING PROVISIONAL PATENT APPLICATION

Dear Sir:

The accompanying application, entitled **METHOD OF FORMING FREESTANDING THIN CHROMIUM COMPONENTS FOR AN ELECTROCHEMICAL CONVERTER USING COMBINED PROCESSING TECHNIQUES** is a provisional patent application under 37 C.F.R. §1.51(c) and §1.53(c).

1. ☒ The name(s) and address(es) of the inventor(s) of this application is/are as follows:

| | Last Name | First Name | Middle Initial | Residence |
|---|-----------|------------|----------------|---|
| 1 | Hsu | Michael | S. | 56 Round Hill Road Lincoln, MA 01773 USA |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |

2. ☐ This invention was made by an agency of the United States Government or under contract with an agency of the United States Government. The name of the U.S. Government agency and the Government contract number are:

Agency: _____

Contract No.: _____

3. ☒ The following documents are enclosed:

☒ 2 page(s) of specification

☐ _____ sheet(s) of drawings

☐ _____ page(s) of claims

☐ _____ page(s) of power of attorney

4. ☒ Applicant claims small entity status. See 37 CFR 1.27.

5. ☐ An Assignment of the invention to _____ is enclosed.
A check in the amount of \$40.00 for recording this assignment and a recordation form cover sheet (Form PTO 1595) are also enclosed.

6. ☒ The fee for filing this provisional application, as set forth in 37 CFR 1.16(k), is \$80.00.

- a. ☐ A check for this filing fee is enclosed.
b. ☒ Charge the filing fee to **Deposit Account No. 12-0080**. (A duplicate copy of this sheet is enclosed.)
c. ☐ The filing fee is not being paid at this time.

7. ☒ Please charge any fee deficiencies associated with this filing to Deposit Account No. 12-0080. A duplicate copy of this sheet is enclosed.

8. ☒ Please address all future communications to: **Customer Number: 000959** whose address is:

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Respectfully submitted,

August 13, 2002
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METHOD OF FORMING FREESTANDING THIN CHROMIUM COMPONENTS FOR AN ELECTROCHEMICAL CONVERTER USING COMBINED PROCESSING TECHNIQUES

Background of the Invention

Presently, chromium alloys are typically suitable for high temperature applications that include employ ambient air to form an oxidation environment. One such application includes the use of fuel cells in the power industry. High temperature fuel cells generally employ components that need to satisfy a number of demanding requirements, including the use of a thermally conductive metal of 10 btu/F-ft-hr and an electrically conductive metal of 10^4 mho/cm; low thermal expansion ceramics of 5×10^{-6} in/in-F; lightweight thin plate of 0.02 inch; gas tight structure with no gas permeation; and must have an oxidation resistant up to 1000°C and a low cost for high quantity production at less than \$10/lb.

Further, steel alloys cannot be applied at temperature above 600°C in air. Nickel alloys have a relatively high thermal expansion coefficient of 9×10^{-6} in/in-F. Advantageously, platinum meets most of the rigorous high temperature requirements, but is very expensive.

Summary of the Invention

Silicon Carbide and Chromium alloys are two materials that can be used if fabricated in a cost effective manner. Hot press processes have been successfully developed for these materials for thickness of 0.05" or greater.

Tape casting and hot press are two traditional methods to produce structures composed of these materials. In order to achieve better component performance, a method combining ceramic tape casting and hot press has been employed, as opposed to using either one exclusively.

The process of the present invention includes forming a free standing thin plate through using a tape cast method to form thin green sheets, and then applying a hot press method to densify the sheet to a near zero porosity state.

The process of the present invention can also include subjecting the green sheet to a furnace sintering process before the hot press process.

The process of the present invention can be applied to silicon carbide SiC, high chromium alloys, chromium iron alloys (Cr-5wt%Fe-1wt%Y₂O₃) and chromium magnesium alloys (Cr-5wt%Ni-1wt%MgO).

We incorporate the teachings of the following patents by reference: U.S. Patent 5,833,822, U.S. Patent 5,747,185, U.S. Patent 5,338,622, U.S. Patent 4,721,556, and U.S. Patent 4,629,537.

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